

*REMARKS*

In response to the Office Action mailed October 23, 2003, Applicants amend their application and request reconsideration. In this Amendment, non-elected claims 11-20 are cancelled. In addition, examined claim 7 is cancelled and new claims 21-29 are added. Accordingly, claims 1-6, 8-10, and 21-29 are now pending.

The Examiner requested a more specific title and a substitute title is supplied.

In this Amendment the invention as defined by claim 1, the only pending independent claim, is clarified by explaining that the etching gas is evacuated from the chamber. The evacuation is expressly mentioned to complete the description of the invention in claim 1. The evacuation is carried out so that the etching gas does not remain in contact with the first part of the wafer significantly beyond the second starting time so that the etching of, and damage to, the second part of the wafer is avoided. The description throughout the patent application of embodiments of the invention describes the evacuation of the contents of the chamber, supporting the amendment to claim 1.

Claim 1 is also amended to clarify how the first and second starting times are determined. The first starting time is the time it takes for the reaction between the etching gas and the first part of the wafer to generate enough water to cause the etching rate to abruptly increase. The second starting time is the time it takes for the reaction between the etching gas and the second part of the wafer to generate enough water to cause the etching rate to abruptly increase (see page 13, line 17 to page 14, line 10 of the patent application). Those aspects of the invention are now clarified in amended claim 1. All other amendments to claim 1 are to correct possibly informal or awkward language.

Claims 1-6 and 8-10 are amended only to the extent necessary to conform to the amendments as to form of claim 1.

New claims 21-26 explain in more detail various aspects of the invention. Claims 21 and 24 describe the repeated etching of the first part of the wafer with etching gas in repeated, sequential steps. This process is described in the patent application beginning at page 14, line 30 particularly in conjunction with Figure 8 of the patent application. New claims 22 and 23 describe sequential supplying of the etching gas and the evacuation of the etching gas illustrated in the time charts of Figures 8 and 19. Figure 11 supports new claim 25. That claim 25 describes continuous evacuation as the etching gas is repeatedly introduced into the chamber in a pulse-like fashion. Claims 25 and 26 describe processes similar to claims 23 and 24 but with the addition of a reaction accelerating gas that is supplied in pulses immediately before the supplying of the etching gas. Claim 25

specifies that the evacuation occurs after each pulse of the accelerating gas and the etching gas is supplied, as illustrated in Figure 21 of the patent application. Claim 26 specifies a continuous evacuation as in the process illustrated in Figure 13 of the patent application.

New claims 27-28 are based on embodiments described in the patent application in which the reaction accelerating gas is one of water vapor, oxygen, ozone, nitrogen, helium, neon, and alcohol (see page 27, lines 24-27 of the patent application). New claim 29 specifies that the first time period is the time during which etching occurs (see page 13, line 30 to page 14, line 7 of the patent application).

The important point of the invention is the controlled introduction of an etching gas within a reaction chamber to etch and remove reaction products from an earlier process step. These processes are carried out on semiconductor devices, such as gate insulating films, that can be undesirably attacked by the etching gas. Typically, these films are not immediately etched but can be etched if exposed for a sufficient period of time to the etching gas. In the invention, an insulating film that is not to be etched is exposed to an etching gas only for a period of time that would not result in undesirable etching of the insulating film. Another film is etched during that time period. To achieve the desired result, of course, any etching gas introduced needs to be evacuated from the chamber before the undesired etching of the insulating film begins. It is this process, carried out in repeated steps, if necessary, that is employed to remove residual reaction products, without damaging the insulating film, that is the important concept of the invention.

Claims 1, 2, and 4-7 were rejected as unpatentable over Komada (U.S. Patent 6,627,554). This rejection is respectfully traversed, as to the examined claims as well as to the claims now pending.

The description of Komada seems to be accurate although not relevant to the invention as claimed. Applicants agree that Komada describes the problem of removal of residual etching products produced in the course of manufacturing semiconductor devices. The passage of Komada to which attention was directed describes a reaction product 113 that is removed using hydrofluoric acid after a resist, to which the reaction product adhered, has been removed from the structure. To remove the reaction product, Komada employs a compound including fluorine in a gaseous phase, apparently in combination with oxygen, citing hydrofluoric acid and  $\text{CF}_4$  as exemplary compounds of fluorine. The Office Action also states that it is known in the art to remove insulating films with hydrofluoric acid. That statement is certainly correct with respect to oxides of

silicon although other insulating films are more or less resistant to hydrofluoric acid. Thus, the statement in the Office Action is unduly broad. The Examiner also states, and Applicants do not dispute, that different materials are etched at different rates by particular etchants. It is notable that the facts thus recited, taken from column 2 of Komada, all concern what Komada considers to be the prior art.

The Examiner states that Komada teaches removing the reaction products without causing any problem in fabricating a semiconductor device. This statement is understood to say that the disclosure of Komada, of what Komada considers to be his invention, is a technique for removing a reaction product without causing damage to the remainder of the structure being processed. In the first example of such a process, Komada describes an extra step of reactive ion etching (RIE) in a mixture of argon and oxygen to avoid the use of a fluorine-containing compound gas. Komada, quite contrary to what the Examiner states at page 3 in lines 15-17 of the Office Action, does not teach using a fluorine compound such as  $\text{CF}_4$  to remove a residual reaction product. What Komada teaches is that **no** fluorine compound should be used to remove a reaction product and that the reaction product removal process should not occur in a simple etching step with a gas as in the invention. There has been confusion in the Office Action between what is described in Komada as prior art and what is described as an invention overcoming the prior art. The conclusion drawn, based upon the inappropriate mixing of these two opposed sources of information within Komada, is incorrect.

What one can learn from Komada is that there are gaseous etching processes used in manufacturing semiconductor devices in which some of the gaseous etchants contain fluorine and some do not. It is not apparent, and certainly not obvious within the meaning of 35 U.S.C. 103, how one of skill in the art, through routine experimentation would then find it obvious to modify Komada to provide timing limitations in the supplying of an etching gas to achieve the advantages that are described in the present patent application. No reference is made in the first rejection, based solely upon Komada, to any special timing feature described in Komada, much less a sequential timing feature, as in the invention. Thus, the rejection of any of the examined claims as obvious over Komada considered by itself is legally and factually deficient and cannot properly be maintained.

Claims 1-10 were rejected as unpatentable over Satoh (U.S. Patent 6,144,087) in view of Komada. This rejection is respectfully traversed.

Satoh was cited with regard to the structure of and manufacturing of a gate electrode and a gate insulating film on a substrate. The Examiner directed attention to the abstract and the passage at column 4, lines 15-40 of Satoh. That passage of Satoh

describes what Satoh considers the prior art and the problem of removing reaction products produced by etching with hydrogen bromide. Applicants agree with the Examiner that Satoh describes a prior art process of removing those reaction products by treatment with an aqueous solution of hydrofluoric acid.

The difference between an aqueous solution of hydrofluoric acid as used by Satoh and the hydrofluoric acid gas used in the invention is readily apparent. The Examiner seems to state at lines 4 and 5 of page 4 of the Office Action that there is no difference between these materials, referring to a "so-called hydrofluoric acid gas". It is elementary knowledge within inorganic chemistry that HF is a gas and that the aqueous solution results from the dissolving of that gas in water. Moreover, it is apparent from the claims, as well as from the specification of the present patent application, that the gas is employed in the invention when the etching gas is hydrogen fluoride. Satoh employs the aqueous solution. The difference in phases of aqueous hydrogen fluoride and gaseous hydrogen fluoride is too fundamental to require extended discussion. The claims cannot be properly rejected based upon an alleged identity of these two reagents.

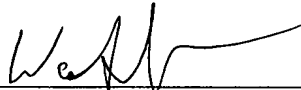
In the second rejection, the Examiner correctly states that Komada teaches using hydrogen fluoride or another fluorine-containing compound to remove a reaction product. Applicants agree that hydrofluoric acid can be employed to etch oxides of silicon, although it is not apparent that all insulating layers can be etched with that compound.

As in the first rejection, the Examiner uses correct information to draw an incorrect conclusion, unsupported by anything in Satoh or Komada, that one of skill in the art would automatically, through some kind of optimization based upon no disclosure in either reference, find the claimed invention obvious. This conclusion is based upon the same faulty premise that Komada teaches removing reaction products without problem using a fluorine-containing compound. As discussed above, that statement, at a minimum, misconstrues the disclosure of Komada and Satoh does not provide any disclosure that explains, supports, or suggests modification of Komada to produce the claimed invention. No suggestion appears in either reference for exploiting differential etching by controlling the duration of exposure to an etchant of materials etching at different rates and/or times. *Prima facie* obviousness has not been established with respect to either rejection as to any examined or pending claim.

In re Appln. of SHINTANI et al.  
Application No. 09/934,453

Reconsideration and allowance of all claims now pending are earnestly solicited.

Respectfully submitted,



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